CHROMOSOME NUMBERS IN MENTZELIA (LOASACEAE)

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The species of *Mentzelia* in Section *Trachyphytum* have been variously delimited in the manuals and floras of California and the most recent taxonomic revision of the genus (Darlington, 1934), but none of these treatments has proved adequate for the identification of all the taxa, particularly those on the California deserts. For several years the junior author, together with his students in an advanced systematics course, have made population studies and chromosome counts of taxa in Section *Trachyphytum* in an attempt to ascertain species limits and the basis of the taxonomic confusion. It soon became evident that polyploidy and to some extent interspecific hybridization were both contributors to the problem. More recently the senior author has extended the earlier observations and has examined the chromosomes of species in sections *Bartonia* and *Mentzelia*. It is the purpose of this paper to present our observations of chromosome numbers in the genus and to indicate their relationship to the delimitation of the various taxa.

The chromosome numbers obtained and their source are shown in the accompanying table. The basic number of the genus is apparently 9. All of the chromosome numbers are reported for the first time except *M. lindleyi* which was first published by Sugiura (1936). Our counts were made from microsporocytes fixed in acetic alcohol (1:3) and squashed in aceto-lacmoid or aceto-orcein. Permanent slides and herbarium sheets of the material examined are on file in the herbarium of the University of California, Los Angeles, except for the collection of *M. multiflora* (*Munz 11714*) which is in the herbarium of the Rancho Santa Ana Botanic Garden. We are grateful to Dr. Munz for furnishing buds of this species.

Section Trachyphytum. This section consists of several apparently well defined species which are morphologically quite uniform, and two variable species groups, one of which includes a polyploid complex. One of the morphologically well defined species, *Mentzelia micrantha* (H. & A.) T. & G. has been examined cytologically. It is diploid (n=9), consisting of small-flowered plants with smooth, angular seeds and it is the only species in this section with dilated outer filaments. *Mentzelia micrantha* is one of the least variable species of the section and occurs in cismontane California and adjacent Baja California, Mexico.

One of the variable species groups includes the taxa which have been described as *Mentzelia affinis* Greene and *M. dispersa* Wats. Together they are clearly separated from the remainder of the section discussed below by the conformation of the seeds which are smooth, angular, and with grooves along the margins. However, the taxa within this group are at present not clearly defined. The two chromosome counts that we have obtained, both diploid (n=9), are apparently best referred to *M. affinis*.

The remaining group of closely related and often variable species is characterized by rounded, papillose seeds and includes diploid, tetra-

ploid, hexaploid, and octaploid taxa. This group has most often been considered to be five species, but such a treatment does not account for several more or less constant morphological types. Furthermore, the morphological differences are correlated with differences in chromosome number which indicate a genetical discontinuity. In general we have assigned names to the material we have examined in this group in accordance with the classification of Abrams (1951) in which seven species were recognized.

We have found four species to be diploid, two tetraploid, one hexaploid, and one octaploid. Three of the diploid species (n=9), *Mentzelia gracilenta* T. & G., *M. pectinata* Kell., and *M. nitens* Greene, have large flowers with petals 10–25 mm. long. The first two species occur west of the Sierra Nevada axis and differ conspicuously in flower color. *Mentzelia pectinata* has bright orange-red flowers while those of *M. gracilenta* are yellow to cream. *Mentzelia nitens* occurs only on the desert and has bright yellow flowers. The fourth diploid species, *M. congesta* (Nutt.) T. & G., can be recognized by its congested inflorescence with membranous bracts and small yellow flowers with petals about 5 mm. long. In California *M. congesta* is restricted to the mountains, occurring generally above 6000 feet. The two tetraploid species (n=18) are *M. Lindleyi* T. & G. and *M. veatchiana* Kell. *Mentzelia lindleyi* is a large-flowered species with petals 20–40 mm. long in which there are two morphogeographic units that differ slightly in a number of characteristics. *Mentzelia lindleyi* subsp. *lindleyi* has relatively broad petals that are a golden yellow with a prominent orange spot at the base. It is endemic to the inner coast ranges of central California and is often grown as an ornamental. It is from cultivated material that the chromosome number was first determined by Sugiura (1936). *Mentzelia lindleyi* subsp. *crocea* Wolf has more narrow petals that are yellow with a less obvious orange spot at the base. It is endemic to the foothills of the western slope of the southern Sierra Nevada. *Mentzelia veatchiana* and all of the other polyploids, except *M. lindleyi*, form a complex which is confined to the deserts or the mountains marginal to them. *Mentzelia veatchiana* has petals 7–12 mm. long which are intermediate between those of the diploid species on the one hand, and those of the hexaploid (n=27) and octaploid (n=36) species on the other. The hexaploid species *M. albicaulis* Doug. and the octaploid species *M. gracilis* (Rydb.) Thompson and Lewis[1] are comparable in flower size with petals 3–6 mm. long, but they differ conspicuously in leaf shape. The characteristic leaves of *M. albicaulis* have shallow and regularly scalloped margins while those of *M. gracilis* are irregularly divided. The correlation between higher chromosome number and smaller flower size in this desert group is of particular interest because it is comparable to that found in

[1] **Mentzelia gracilis** (Rydb.) Thompson and Lewis comb. nov., based upon the type of *Acrolasia gracilis* Rydberg, Bull. Torrey Club 31:566. 1904. *J. H. Cowen,* June 1, 1895, foothills, Larimer County, Colorado, NY!

Table I. Mentzelia Collections Examined Cytologically

Species	Chromosome Numbers (n)	Collector	Locality
Sect. Trachyphytum			
M. micrantha	9	*Thompson 1559,* June 11, 1953	San Gabriel Canyon at West Fork, Los Angeles Co., Calif.
M. micrantha	9	*R. Snow,* June 23, 1953	9.6 mi. N. of Wheeler Hot Springs, Ventura Co., Calif.
M. affinis	9	*H. Lewis,* May 2, 1952	Between Coalinga and Panoche Pass, Fresno Co., Calif.
M. affinis	9	*Thompson & H. Lewis 1557,* June 3, 1953	5.5 mi. E. of Edison, Kern Co., Calif.
M. gracilenta	9	*H. Lewis & M. Lewis,* May 1, 1952	10 mi. W. of Simler, San Luis Obispo Co., Calif.
M. gracilenta	9	*H. Lewis & M. Lewis,* April 30, 1952	Cuyama Valley near Ventura-Santa Barbara Co. line, Ventura Co., Calif.
M. pectinata	9	*H. Lewis & M. Lewis,* April 19, 1952	Kern River Canyon, 0.2 mi. from mouth, Kern Co., Calif.
M. pectinata	9	*Thompson & H. Lewis 1589,* April 10, 1954	Temblor Range, W. of Maricopa, Kern Co., Calif.
M. pectinata	9	*Thompson & H. Lewis 1590,* April 11, 1954	W. slope of Temblor Range at Crocker Grade, San Luis Obispo Co., Calif.
M. nitens	9	*H. Lewis,* April 8, 1950	Atolia, San Bernardino Co., Calif.
M. nitens	9	*Thompson, H. Lewis, & Mathias 1599,* April 17, 1954	Near Red Rock Canyon, Kern Co., Calif.
M. congesta	9	*Thompson 1624,* May 29, 1954	Summit of Mt. Pinos, Ventura Co., Calif.
M. lindleyi subsp. *lindleyi*	18	*Thompson 1569,* July 15, 1953	Cultivated strain, UCLA Botanical Garden
M. lindleyi subsp. *lindleyi*	18	*Thompson & H. Lewis 1616,* May 15, 1954	Adobe Creek at del Puerto Road, Stanislaus Co., Calif.
M. lindleyi subsp. *crocea*	18	*Thompson & H. Lewis 1620,* May 16, 1954	Merced River, 6 mi. above Bear Creek, Mariposa Co., Calif.
M. lindleyi subsp. *crocea*	18	*W. Ernst,* August 20, 1953	Plants grown at UCLA from seeds collected at Amphitheater Point, Sequoia National Park, Calif.
M. veatchiana	18	*H. Lewis & M. Lewis,* April 5, 1952	Aqueduct Rd., 5.8 mi. E. of Garnet, Riverside Co., Calif.

Species	Chromosome Numbers (n)	Collector	Locality
M. veatchiana	18	*Thompson 1563,* June 12, 1953	Above Crystal Lake, San Gabriel Mts., Los Angeles Co., Calif.
M. veatchiana	18	*Thompson 1629,* June 25, 1954	S. side of Big Bear Lake, San Bernardino Co., Calif.
M. albicaulis	27	*H. Lewis,* April 8, 1950	Atolia, San Bernardino Co., Calif.
M. gracilis	36	*H. Lewis & M. Lewis,* April 5, 1952	Cottonwood Springs Rd. near Hwy. 60, Riverside Co., Calif.
Sect. Biscuspidaria			
M. involucrata	9	*H. Lewis & M. Lewis,* April 5, 1952	Cottonwood Springs Rd. near Hwy. 60, Riverside Co., Calif.
Sect. Bartonia			
M. multiflora	9	*Munz 11714,* April 10, 1947	Turtle Mts., San Bernardino Co., Calif.
M. laevicaulis	11	*Thompson 1568,* July 10, 1953	Lebec, Kern Co., Calif.
M. laevicaulis	11	*Thompson 1565,* July 15, 1953	Big Tujunga Wash near Sunland, Los Angeles Co., Calif.
M. laevicaulis	11	*Thompson 1573,* Oct. 1, 1953	Crystal Lake, San Gabriel Mts., Los Angeles Co., Calif.
M. laevicaulis	11	*Thompson & H. Lewis, 1555,* May 25, 1953	North Fork of San Jacinto River, Riverside Co., Calif.
M. laevicaulis	11	*Thompson & H. Lewis 1617,* May 17, 1954	Del Puerto Road near Adobe Creek, Stanislaus Co., Calif.
M. laevicaulis	11	*Richard Shaw,* July 17, 1954	Jackson, Teton Co., Wyo.
Sect. Mentzelia			
M. arborescens	14	*Thompson 1581* March 2, 1954	Cultivated plant Vavra Estate, UCLA.

the desert species of *Eschscholtzia* (Lewis and Snow, 1951) and may in both cases be associated with breeding habit.

The polyploid species of *Mentzelia* on the desert sometimes form hybrid swarms. For example, in a particular locality one may find morphological intergradation between *M. veatchiana* and *M. albicaulis* due apparently to interspecific hybridization (e.g. *Lewis* in 1950, one mile south of Atolia, San Bernardino Co., Calif.) although in most areas these species retain their integrity. Interspecific hybridization between polyploid species is undoubtedly a contributor to the variation which tends to obscure specific limits in this group.

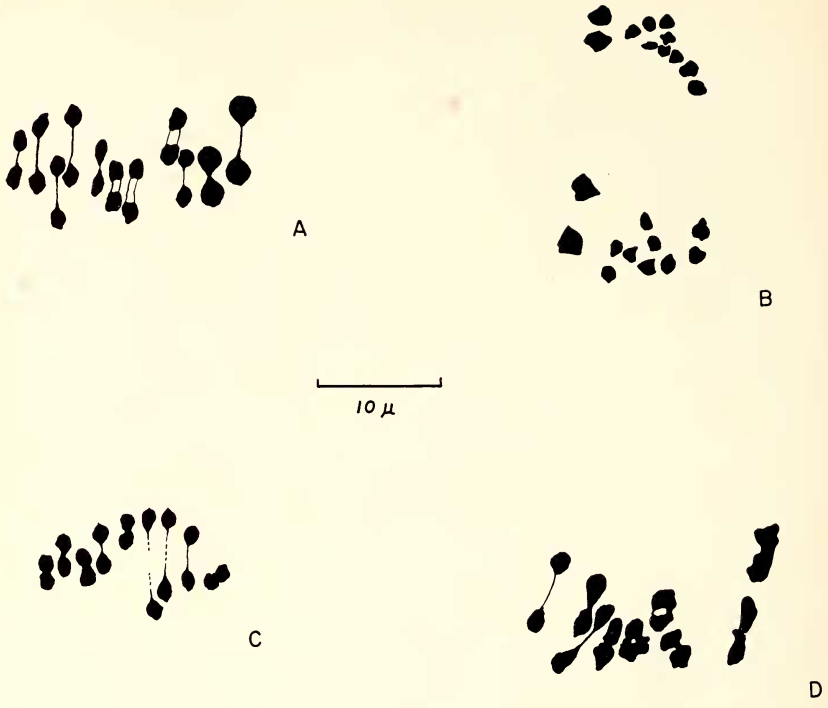

FIG. 1. *Mentzelia* microsporocyte meiosis. A, *M. laevicaulis* M_I. B, *M. laevicaulis*, A_I. *C, M. affinis,* M_I. *D, M. multiflora,* M_I. Camera lucida drawings. All material fixed and treated in the same manner.

SECTION BICUSPIDARIA. One species in this section, *Mentzelia involucrata* Wats. has been examined cytologically and found to be diploid (n=9).

SECTION BARTONIA. We have examined two species in this section, *Mentzelia multiflora* (Nutt.) Gray and *M. laevicaulis* (Doug.) T. & G. Both species are diploid, but the former has 9 pairs of chromosomes while *M. laevicaulis* has 11 pairs. Populations of the latter species which have been examined cytologically have come from six rather widely separated localities. This indicates that the deviation from the usual basic number of 9 is not merely a local variation. Of particular interest, however, is that the chromosomes of *M. laevicaulis* fall into two size classes. At meiosis nine of the chromosome pairs are relatively small and more or less uniform in size while two pairs are conspicuously larger (fig. 1A, B). This suggests that two relatively large chromosomes have been added to a normal diploid complement in the formation of *M. laevicaulis*. Interestingly enough, different species of *Mentzelia* are apparently characterized by chromosomes of different size (fig. 1C, D). This suggests that *M. laevicaulis* may be the product of interspecific hybridization whereby

two chromosomes of one of the parental species have been added to the complete genome of the other. Speciation correlated with the addition of the equivalent of whole chromosomes is now well established for the genus *Clarkia* (Lewis 1953a, b, and 1954) and will be further investigated in *Mentzelia*.

Section Mentzelia. One species in this section, *Mentzelia arborescens* Urban & Gilg has been examined cytologically and found to have 14 pairs of chromosomes. These chromosomes are all approximately the same size and do not fall into two distinct size classes as in *M. laevicaulis*.

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CHROMOSOME COUNTS IN THE SECTION SIMIOLUS OF THE GENUS MIMULUS (SCROPHULARIACEAE)

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This report[1] on the determination of chromosome numbers in the section *Simiolus* of the genus *Mimulus* is an integral part of a long range investigation into the taxonomy, genetics, and evolution of species in *Mimulus* (Vickery, 1951). The chromosome study was undertaken in order to improve our understanding of the many genetic barriers known to be present in the genus, particularly the ones in the most intensively studied section, *Simiolus* (Vickery, 1952). *Mimulus* chromosomes are small, averaging about three-fourths of a micron long by one-half micron wide and are therefore relatively difficult to study. Hence, it was necessary to develop a special technique for this investigation.

The chromosome counts were obtained by smearing anthers and observing meiosis in the pollen mother cells. The procedure consisted of

[1] The work was supported by the Research Fund of the University of Utah. The author wishes to thank Drs. Ira L. Wiggins, William M. Hiesey, and Jens Clausen for their helpful criticisms of the manuscript.